KNOWLEDGE

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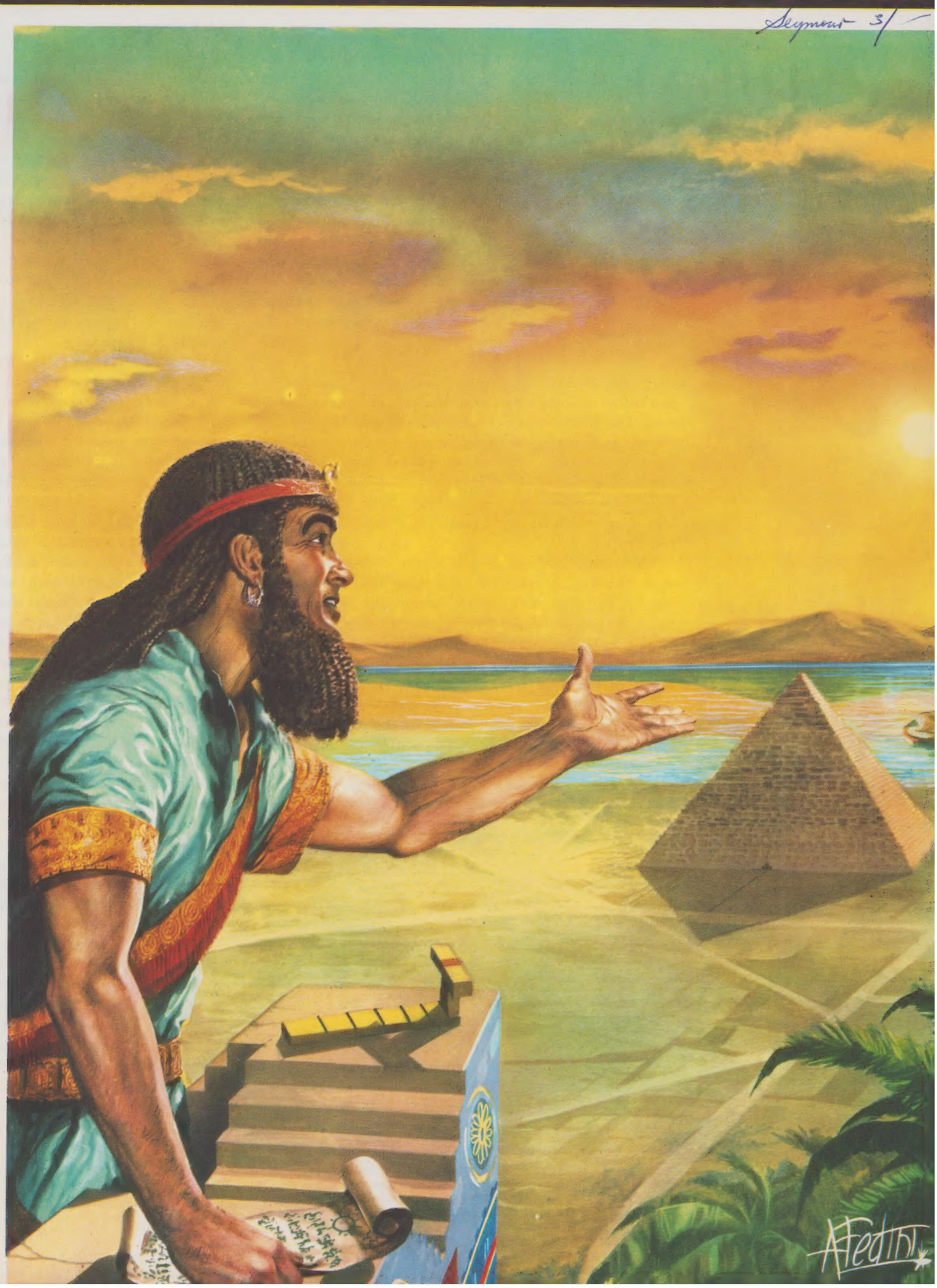

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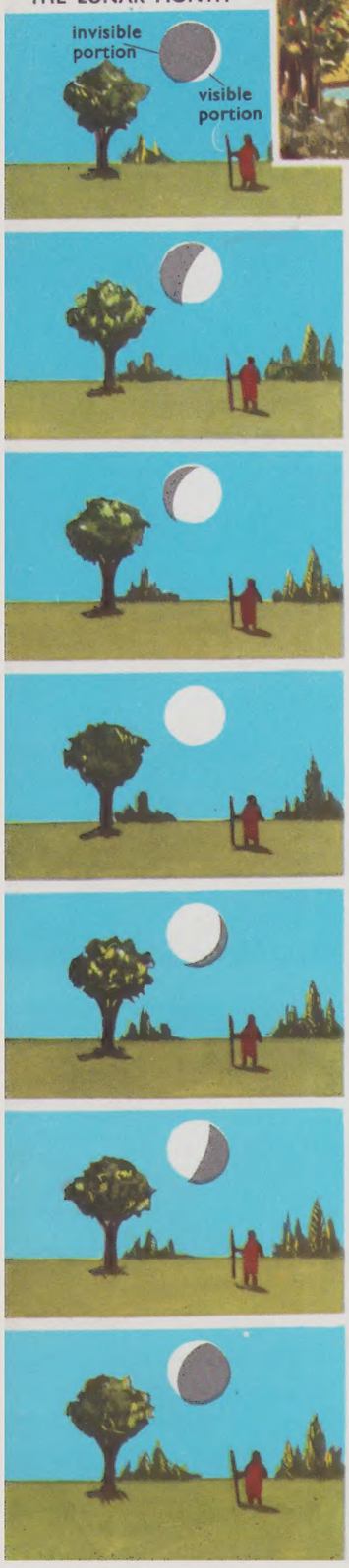
Y THE YEAR



A primitive calendar

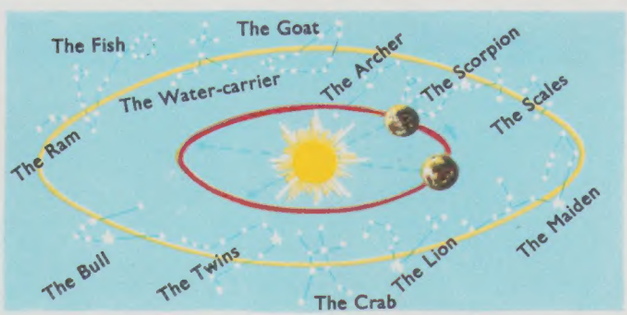
THE day begins with the rising of the Sun; the lunar month with the appearance of the new Moon; but no such sign tells us when a new year starts. No natural events mark its beginning or end, nor is it possible easily to determine its length. Primitive men must have noticed its recurring passage by the sprouting of the leaves on the trees each spring, and by the ripening of seeds each autumn, but naturally they used the shorter, more obvious measurements.

The day is the most obvious of all units of time, for it is marked so definitely by the alternation of light and darkness. This alternation is so dominating that it has determined the living habits of almost all animals, even of man himself, and thus for common use the day has become the basic time unit. All that primitive man needed to count the passage of time in days was a convenient tree upon which he could mark each rising or setting of the Sun.

The month is a rather less obvious measure of time than the day, particularly for those who live in artificially lit cities in cloudy, temperate regions. For the early peoples of the Earth, however, the Moon shone clearly in the sky at night and her waxing and waning marked out a convenient period. The time from one new Moon to the next was, for all practical purposes, 29½ days, or one *lunar month*.

The early farmers must surely have noticed that the spring, summer, autumn, and winter seasons which

As the Earth spins on her year-long journey around the Sun the constellations steadily change in a cycle of 365¼ *days*



followed each other so regularly were each roughly three lunar months, or 90 days, long. Since they could only farm successfully by strictly regarding the seasons, the recurring cycle of the four seasons must soon have led to the concept of a year of 12 lunar months.

A small mistake

Among the Ancient Egyptians the priests were the foremost astronomers. They studied the heavens chiefly for religious purposes, and such was their skill that they knew well how to determine the day in each year when the Sun rose highest in the sky – Midsummer's Day. Consequently they could measure the length of the year quite accurately merely by counting the days from one Midsummer's Day to the next. Furthermore, since they were familiar with the constellations, they knew how those parts of the heavens near to the horizon dipped out of sight in the west as the year progressed, only to return in the east and resume their positions in the sky almost exactly 365 days later.

Unfortunately, when the Egyptians chose 365 days for their year their choice was not quite perfect. As a result, the calendar which they based on the 365-day year got out of step with the seasons. With the passing years it became less and less useful, particularly for predicting natural seasonal events such as the flooding of the Nile.

The tropical or solar year

As the Earth makes its yearly journey around the Sun the tilt of its axis is such that the angle at which the Sun's rays strike each part of the Earth's surface steadily changes. When the North Pole is tilted towards the Sun the rays fall more directly on the Northern Hemisphere, and thus that hemisphere experiences summer. There is one day – Midsummer's Day – when at a point on the Tropic of Cancer the Sun is immediately overhead. This is the *summer solstice*. From then on the Sun rises a little less high in the sky each day until Midwinter's Day. This, in the Northern Hemisphere, is the *winter solstice*; and at this time the Sun is over the tropic of Capricorn. The Sun then begins to climb again until it is once more immediately above the Tropic of Cancer, and Midsummer's Day and the summer solstice recur. The period of time between one summer solstice and the next is known as a *tropical* or *solar year*, and it is an exact measure of the length of a year as it is experienced on Earth.

There is no natural reason why the Earth should rotate on its own axis an exact number of times during a tropical year, and, indeed, it does not do so. In fact, during one tropical year the Earth completes very nearly 365 *and a quarter* revolutions. Thus when four tropical years have elapsed and Midsummer's Day comes round for the fourth time, the Earth has completed $4 \times 365\frac{1}{4}$ revolutions, and the people have experienced that number of days. One day of a *fifth* year in the Egyptian calendar will therefore have passed before the Earth reaches Mid-

Previous page: An Ancient Egyptian priest uses a *gnomon* to tell the time of day by the Sun. As the Sun rises in the sky the shadow cast by the vertical portion of the gnomon shortens and thus reaches less far along the horizontal portion.

Two visitors from Europe find Eastern spices a little too hot for their taste

THE SPICE TRADE

TODAY we take spices for granted. A pot of pepper on the table, the flavour of vanilla in ice-cream, and of ginger in ginger biscuits, are all familiar enough; so are spices like mustard, cloves, aniseed, and nutmeg. But not so many generations ago some spices were literally worth their weight in gold, and seamen made long, hazardous voyages to reach the land where the plants from which they were obtained grew. The spice trade became one of the most romantic and dramatic stories in the history of commerce.

It is said that the enthusiasm of Europeans for spices (see page 490) was fired by the Crusaders, who, returning from their wars, brought back with them a taste for spices from the East. This is not surprising, for in those days no farmer knew how to keep all his stock alive through the winter, and thus by the beginning of spring the only meat available had been preserved far too long to be appetising. A generous application of spice at least made it edible, if still not exactly enjoyable.

In the Middle Ages almost all spices came from the East, though no one in Europe knew from exactly where. They were brought overland by Arab traders and, after their long and perilous journey, were sold to the merchants of Venice and Genoa. From these two cities the spices were carried by land and sea and sold, at prices so exorbitant that only rich people could afford them, in every part of Europe.

The cities of Venice and Genoa grew rich on the profits made by their merchants, and people in many other parts of Europe came to covet both their spices and the wealth that they brought. In particular the rulers of Portugal and Spain saw in the spice trade an irresistible opportunity to enrich both themselves and their countries.

With royal patronage and encouragement Portuguese sailors set out to discover a way to the spice lands by sea, and in 1495 Vasco da Gama reached India's Malabar coast, where he found spices in abundance. Seventeen years later, sailing farther east, the Portuguese reached the legendary Spice Islands, the Moluccas, so ending their quest.

Many parts of many plants are used as the sources of the spices that we use
Cardamon (fruit)
Ginger (rhizome)
Pepper (fruit)
Cinnamon (bark)
Clove (flower bud)

HOW SPICES ARE PREPARED

The pungent substances which give spices their distinctive flavours occur only in certain parts of the spice-bearing plants. Vanilla, for example, is found in a seed pod, ginger in a root, and nutmeg in a kernel. The preparation of spices is therefore a complex process in which the spice-bearing part of the plant has to be separated from the remainder. A drying stage is often necessary so that the spice loses none of its flavour if it is kept for a while.

Some spices are sold much as they are when obtained from the plant, and everyone is familiar with the clove bud and the nutmeg. Sometimes, however, they are more useful as powders, and for this reason pepper, cinnamon, and mace can all be bought in a finely ground condition. Yet another way of capturing the flavour of spices is to grind the raw spice with water and then to distil the mixture. Oil of cloves, nutmeg oil, and peppermint oil are all obtained in this way.

SPICES IN THE KITCHEN

Many English cooks use spices rather sparingly, as traditional English cooking concentrates on bringing out the natural flavours of the best ingredients rather than adding new flavours to them. Even so, certain English dishes are almost always enlivened by a little of one of the spices, and many people do not like brussels sprouts without pepper, ham without mustard, or apple pie without cloves. Spices, such as cinnamon, are also used in many kinds of sugary buns and in pickles, particularly chutneys.

In countries overseas, cooks use spices much more freely. French cooks use aniseed for the flavouring of many kinds of cake, and Hungarian goulash and other traditional Hungarian dishes would be impossible without paprika. In India and several other Far Eastern countries highly-spiced curries are the most commonly eaten dishes. More than 30 different ingredients are used in some kinds of curry; among them are the spices coriander, cumin, tumeric, ginger, as well as different quantities of peppers depending on the degree of 'hotness' which the cook wishes to provide. Even the rice which is eaten with the curry may be spiced with saffron.

SPICES IN THE WINE CELLAR

The raw spirit produced by the distillation of wine or other fermented liquors is intoxicating, but, except in the case of brandy, it is seldom palatable. Because of this the manufacturers of spiritous liquors have for hundreds of years added herbs or spices to their beverages to make them pleasant to drink. Liqueurs, in particular, are made in this way. Among the many spiced liqueurs are *anis* or *anisette*, which is flavoured with aniseed; *crème de menthe*, which contains cinnamon, ginger, and large amounts of peppermint; and *curaçao*, which contains cinnamon and cloves. *Vermouth* has more than 50 different flavouring agents.

SPICES IN PHARMACY

Several spices are used in the preparation of medicines, because their strong flavours are an efficient disguise for the unpleasant and bitter tastes of many drugs. Aniseed, cinnamon, caraway, cardamon, and ginger are all used in this way. Mustard was at one time used in foot baths, which were thought not only to relieve tired feet, but to be good for a cold in the nose.

A SPICE IN DENTAL SURGERY

When cloves, the unopened flower buds of the clove tree, are distilled with water a pungent aromatic liquor known as *oil of cloves* is obtained. This oil has antiseptic and analgesic properties, and it is used by dentists in dressings for bad teeth. It is also used to make a paste of magnesium carbonate, which is used in large fillings.

Spices are grown in many tropical and subtropical countries and also in several temperate regions. Some are native species, others are species imported from the natural homes of the spice plants

PLANTS OF SOME COMMON SPICES

Cinnamon (*Cinnamomum zeylanicum*). The small evergreen cinnamon tree is a native of Ceylon, from which country the world's finest cinnamon is obtained. The spice consists of the underbark of the tree, and it is sold either in sticks or as a powder. Cinnamon oil is made by macerating the bark with water followed by distillation of the mixture.

Several other plants of the genus *Cinnamomum* are also used as spices.

Vanilla (*Vanilla planifolia*). Madagascar is the chief centre of vanilla production. The vanilla plant is a climbing species which bears clusters of pods from which the vanilla is obtained by a complicated sequence of drying and fermentation. The final product, *vanillin*, is dissolved in alcohol for use.

Nutmeg (*Myristica fragrans*). Nutmeg is one of the most famous products of the Spice Islands. The fruits of the nutmeg tree split on ripening to provide a seed covering known as *mace* and a kernel which is the nutmeg.

Mustard (*Sinapis nigra et alba*). Mustard is one of the few spice-bearing plants which will grow well in cool climates. It is cultivated quite extensively in Britain. The seeds are ground to a fine powder, *mustard flour*, from which mustard for cooking is prepared.

Coriander (*Coriander sativum*). Though this spice-bearing plant is probably a native of Asia Minor it grows quite well in the cool climate of southern England. The pea-like seeds are used to season soups and meats.

Aniseed (*Pimpinella anisum*). This plant is cultivated in many parts of Europe. Its seeds are used to make aniseed oil, and the leaves are often used as a herb in salads.

Paprika (*Capsicum annuum*). Many species of plants belonging to the genus *Capsicum* produce fruits known as peppers, though they are in no way related to *Piper nigrum*.

The fruit of *Capsicum annuum* is bright red, and the spice prepared from it is sweet and mild. It is used in sauces and in Hungarian goulash.

Ginger (*Zingiber officinale*). Ginger for cooking and medicines is obtained from the cleaned and dried rhizomes.

Pepper (*Piper nigrum*). A climbing plant rather like ivy is the source of the white pepper found on every dining-room table. From this plant come the small seeds which, depending on the way in which they are harvested and dried, are ground to provide the familiar 'white' pepper and also the much stronger black pepper

Many people prefer to use pepper corns rather than ground pepper. By grinding the corns in a mill as required, they obtain the very best and freshest peppery flavour.

Cloves (*Eugenia caryophyllata*). Cloves came originally from the Spice Islands, but the tree is now grown extensively in Madagascar and Zanzibar. Each clove is a flower bud plucked from the tree before it has opened, and dried in the sun.

Saffron (*Crocus sativus*). A quarter of a million stigmata are needed to make a pound of saffron.

EQUATOR, TROPICS, POLAR

The Polar Circles, the Tropics, and the Equator

THE British often complain about the cold in winter: they wrap themselves in warm coats and hurry along the streets; they rub their hands and are glad to reach the warmth of the fireside. In summer it is warm again, and sometimes the British even complain of the heat, as they toil underneath a blazing Sun. But Britain's climate is, when compared with other parts of the world, a moderate one: there are no great extremes of temperature. In winter the temperatures will average about 41°F and in summer about 64°F. Nor are there very heavy falls of snow or rain: in London there is about 26 inches of rain during each year, which falls as frequent light showers. But temperatures in the Congo and in Egypt are always above 80°F – Britain's 'heat-wave' conditions – and there may be no rain for several months, until it falls as a torrential downpour. In the polar regions, on the other hand, the temperatures are nearly always below freezing. Let us examine the cause of these wide differences.

THE EQUATORIAL REGIONS

On the diagram of the globe at the top of the page we have series of black lines making a pattern or grid; those lines which run parallel to one another across the globe are known as lines of latitude. The longest of these is the Equator. This is exactly mid-way between the Poles; from every point on the Equator it is 6,250 miles to the North and South Poles.

The equatorial region is the belt extending roughly 600 miles on both sides of the Equator; it includes the Amazon and Congo river basins, the highlands of Kenya, and the islands of Indonesia in the Pacific.

On 21st March the Sun is vertically overhead at the Tropic of Cancer at midday

In these latitudes dawn and sunset are always short. The Sun rises quickly in the heavens, and although it is exactly overhead only twice a year it is always high at midday. Thus the Sun's rays have a shorter passage through the atmosphere than if they struck it at an oblique angle.

The equinox

The noon-day Sun is exactly overhead twice a year at the Equator: on 21st March (the spring or vernal equinox) and on 22nd September (the autumn equinox). The diagram on the right and the article on **Day-time and Night-time** (see page 2902) help us to understand this. On these dates day and night are of the same length all over the Earth. (*Equinox* is a Latin word meaning equal night.)

The climate

In the equatorial regions there is no cold season or winter, no regular blossoming forth of leaves on the trees, no cyclical flowering, growing, and changing of colour – the sequence of events so familiar in Britain. Here all vegetation can grow rapidly at all times of the year, since it is always hot – for example, the average temperatures at Manaus in Brazil are between 80°F and 83°F for every month of the year. Regular afternoon thunderstorms bring large amounts of rain, often over 6 inches in each month. The result is a hot and sticky climate in which luxuriant forest vegetation flourishes, but which is unhealthy to man. This is modified by the height of the land. While the highlands of Kenya are healthy and not extreme in climate, the Congo lowlands are a steaming jungle.

THE TROPICS

The two Tropics mark the limits of the zone of Earth which sees the Sun directly overhead at some time in the year. They are both on latitude $23\frac{1}{2}°$: the Tropic of

THE POLAR REGIONS

The north polar region, the area within the Arctic Circle, or north of the latitude $66\frac{1}{2}°$, is one of the coldest parts of the Earth. Atlases show the North Pole as an ocean, but in fact it is so cold that the sea is frozen and a great ice-cap permanently covers the Pole. This ice-sheet is several thousand feet thick at the centre but thins at the edges, where holes can be made in it and from which floes break off and float away as icebergs. In Greenland the polar ice-sheet extends south 400 miles beyond the Arctic Circle, though north of Norway the warm water of the North Atlantic drift keeps the sea open nearly to the Pole itself. The south polar region lies within the Antarctic Circle. Like the North Pole, it is a frozen area of ice and snow, but the ice-sheet here covers a great land mass – the continent of Antarctica.

The diagrams on the right show that in summer the North Pole is always in sunlight: it is therefore light for 24 hours each day. Similarly the South Pole is always in darkness. (This is because of the tilt of the Earth's axis, as you can read on page 2996.) In winter the case is reversed, and the North Pole is always in darkness and the South Pole in the Sun. But although both these regions have long days at some part of the year, they are never very warm as the sun is always low in the sky.

The life of the people in these frozen lands is a hard one. The Eskimoes of Greenland find enough food for themselves by fishing and hunting seals. Men operating polar weather observation stations, mining for iron in Lapland, or searching for uranium in Antarctica, have to be supplied from warmer latitudes.

The Earth's position at the equinoxes and at the solstices. Notice that the axis on which the Earth revolves is always tilted in the same way with respect to the Sun

Cancer to the north, the Tropic of Capricorn to the south.

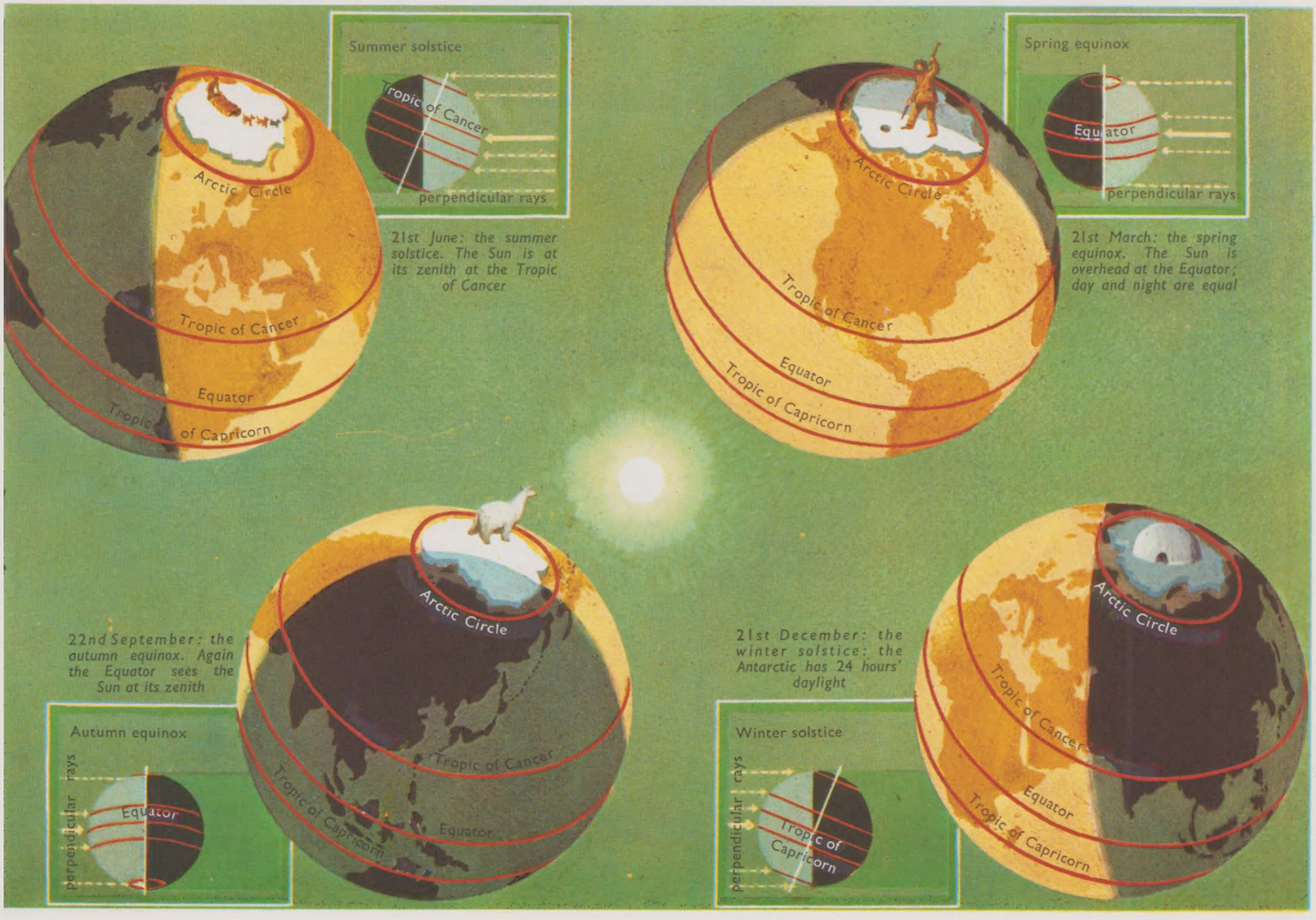
These are the latitudes of the great hot deserts of the Earth: the Sahara, Arabia, Lower California, the Kalahari, and Central Australia. Warm, descending air currents make these dry, hot regions – sometimes even hotter than the equatorial regions. At Aswan, for example, the three warmest months have temperatures of 90°F and above. Yet the winters may be only fairly warm, about 60°F – which is not so much warmer than winters in Britain.

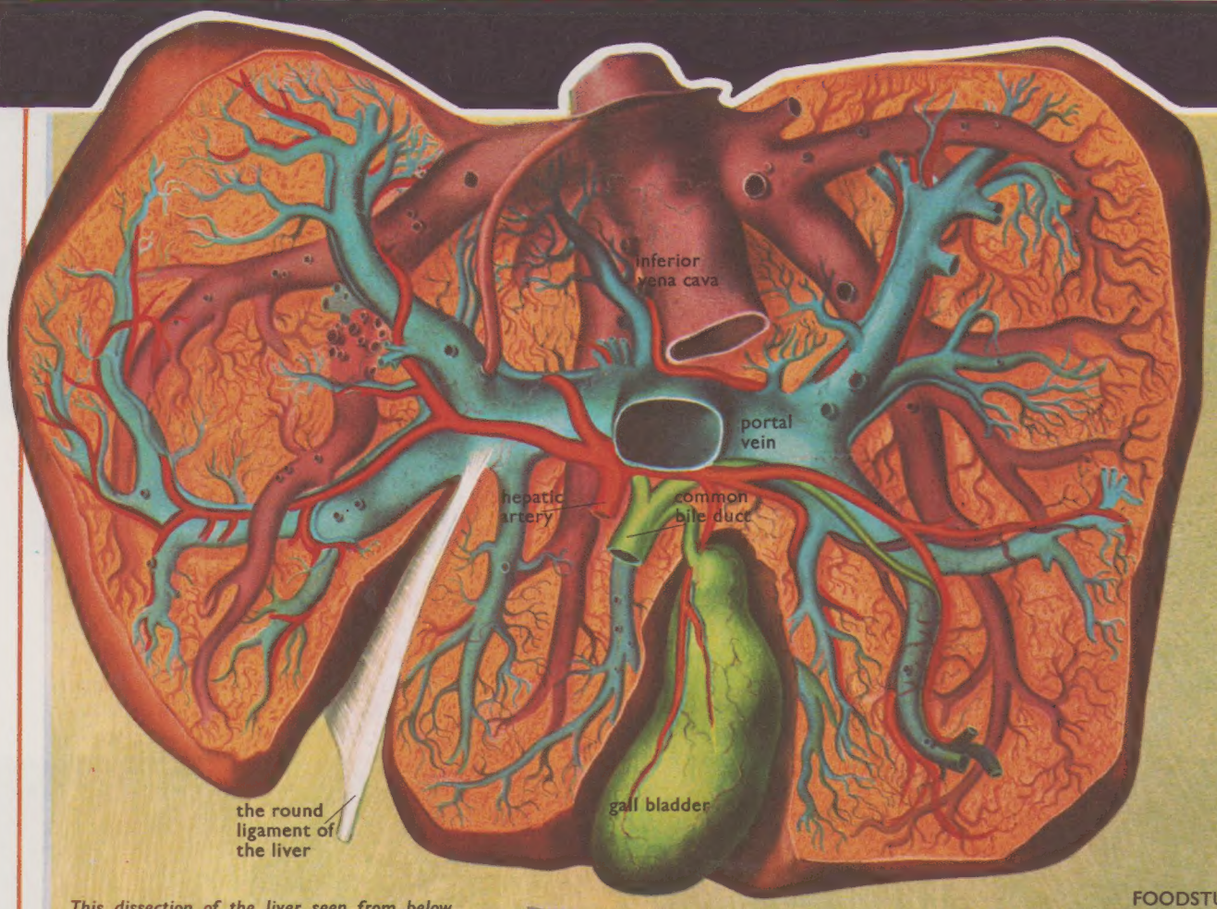
An observation station in the Arctic Circle at midnight on 21st June. Because of the tilt of the Earth's axis there is sunlight for 24 hours a day

The solstices

The Sun is vertically overhead once a year at each of the tropics; on the Summer Solstice (21st June) at the Tropic of Cancer and on the Winter Solstice (21st December) at the Tropic of Capricorn. By summer and winter we mean of course the northern hemisphere summer and winter. Britain's winter solstice is midsummer at the Tropic of Capricorn.

This phenomenon was appreciated long ago. About the year 200 B C the Greek Erastosthenes (see page 503), librarian at Alexandria, noted at Syene on the Upper Nile river, close to the Tropic of Cancer, that on the summer solstice (21st June) the Sun shone directly on the floor of a deep, vertical well. On the same day the midday Sun at Alexandria, farther north, made an angle of 7°12′ with the vertical. He used this information in his calculation of the circumference of the Earth.





This dissection of the liver seen from below illustrates the arrangement of the branches of the portal vein, the hepatic artery, the hepatic vein, and the bile duct

JAUNDICE

Jaundice is a yellow coloration of the skin. It is not a disease in itself, but a symptom which may occur in several diseases. It appears when an excessive amount of the yellow-green pigment *bilirubin* is present in the blood. Inevitably some of this pigment escapes from the blood into the skin, where it causes the characteristic yellow appearance.

In some cases of jaundice it is possible to observe yellow coloration of the eyes in the early stages of the illness, before the colour appears in the skin.

Bilirubin is a very complex biological substance which

FOODSTUFFS UNSUITABLE FOR PEOPLE WITH LIVER DISEASE

PEOPLE who feel a little queasy frequently blame their livers. There is no chance that the much-maligned organ will deny the charges, and it is certainly a very convenient way of 'forgetting' a bout of over-eating the previous day. But if the liver of such a 'liverish' person was examined by a pathologist he would probably find nothing at all wrong with it.

This does not mean that the liver is immune to disease. There are a number of genuine diseases of the liver, many of which make the victims feel very ill indeed.

The liver is the body's 'chemical works', and diseases of the liver usually impair the organ's ability to carry out the reactions which take place within the liver cells. The treatment of liver disease always includes dietary control, as in this way the amount of work which the liver and the bile secreted by it have to do can be reduced, and the patient's condition will consequently be improved.

INFECTIVE HEPATITIS

This common infectious illness is caused by a virus which has a liking for the cells of the liver. When the liver cells are infected they are unable to take up the bilirubin which reaches them from the spleen, and thus the pigment is not transferred to the bile. As a result, the amount of bilirubin in the blood steadily increases. After a time some of the bilirubin diffuses into the skin where it causes the bright-yellow jaundice so characteristic of infective hepatitis. Some also diffuses through the kidneys and into the urine, to which it imparts a deep yellow tinge. Since, in this illness, no bilirubin is excreted by the liver, there is no stercobilin in the faeces, a fact which accounts for their unusually pale colour.

Infective hepatitis is probably transmitted by faecal contamination of foodstuffs and eating utensils. Its incubation period is three to four weeks, and in communities such as schools and military units the introduction of a single case may be the cause of a minor epidemic. Although the disease is an unpleasant one, and the victim often feels that he is going to die, he very seldom does. After about three weeks convalescence may begin, and a complete recovery is usual.

CIRRHOSIS OF THE LIVER

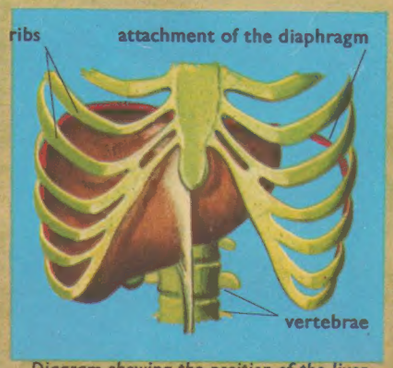


Diagram showing the position of the liver

The illustration above shows the position, the size, and the appearance of the liver in a healthy adult. In the disease known as cirrhosis (pronounced ser-o-sis) of the liver many of the liver cells are slowly replaced by scar tissue, which, in the course of time, contracts so that the

DISORDERS OF THE LIVER

is formed when wornout erythrocytes (see page 880) are destroyed in the spleen. Normally it is carried by the blood from the spleen to the liver, where it is taken up by the liver cells and secreted into the bile. It then passes down the hepatic duct and into the gall bladder, where the bile is concentrated.

When the gall bladder contracts and expels bile into the duodenum the bilirubin mixes with food. Much of it is altered to the brown pigment *stercobilin*, which gives the faeces their colour. Some of the stercobilin is absorbed and returned to the liver where it is converted back to bilirubin.

liver becomes small and very hard. It is sometimes called a *hobnail liver* as there is a slight resemblance between its surface and the soles of nail-studded boots.

The exact cause of this type of cirrhosis is not known with certainty, though it has been evident for many years that the disease occurs most frequently in people who drink large amounts of alcoholic beverages. Gin, in particular, has been held responsible, but there are many who would say that only inferior-quality gin has this effect.

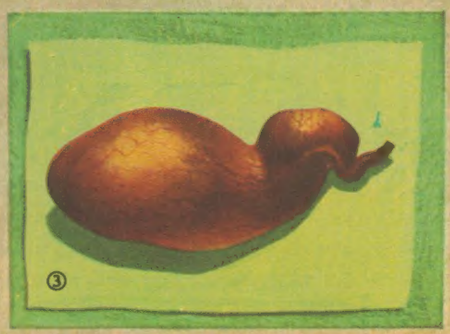
Several other forms of cirrhosis are known, some of which are characterised by shrinking and some by swelling of the liver. They are chiefly caused by infection spreading up the bile ducts.

Although cirrhosis is a serious illness, its victims often live for many years. This is because a healthy liver contains far more cells than are necessary for life; and even though many cells may be replaced by scar tissue, enough remain to do the work.

GALL STONES

Gall stones are solid bodies which form in the gall bladder. They range in size from tiny fragments no bigger than grains of sand to stones the size of hazel nuts. They are usually formed of a mixture of cholesterol, bilirubin, and calcium carbonate, though 'pure' stones consisting of only one of these materials are not unknown.

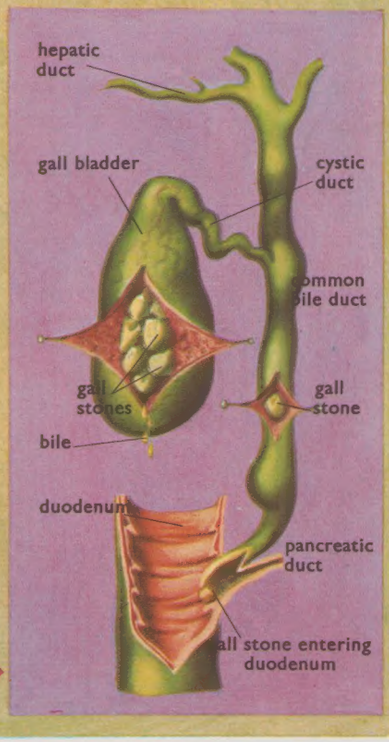
Gall stones cannot usually be seen on an X-ray as their density is not great enough for them to be distinguished from the neighbouring tissues. It is, however, possible to inject into a patient a quantity of a radio-opaque substance which is then secreted by the liver into the bile, and so passes into the gall bladder. When a gall bladder filled in this way is X-rayed any gall stones which it contains can be seen against the radio-opaque background.



① A selection of gall stones, showing various shapes, sizes, and colours
② An X-ray showing the presence of five gall stones lodged in the gall bladder
③ A stone-filled gall bladder removed from a patient by a surgical operation
④ The same gall bladder dissected to show the presence of several stones

Many gall stones are 'silent' and cause no discomfort. Should a stone, however, find its way into the cystic or common bile ducts, an attack of very severe pain follows as the muscles of the gall bladder and ducts try to push it into the duodenum. When the stone reaches the duodenum the pain subsides.

A gall stone which sticks in the common bile duct obstructs the flow of bile into the duodenum. The bile is dammed back towards the liver and thus begins to accumulate in the blood. As the concentration in the blood increases jaundice appears, and remains until either the stone moves on spontaneously or it is removed by a surgeon.



The biliary apparatus, showing sites at which gall stones may become impacted

RICHARD II AND THE

The Tower of London – refuge of the King and his terrified courtiers

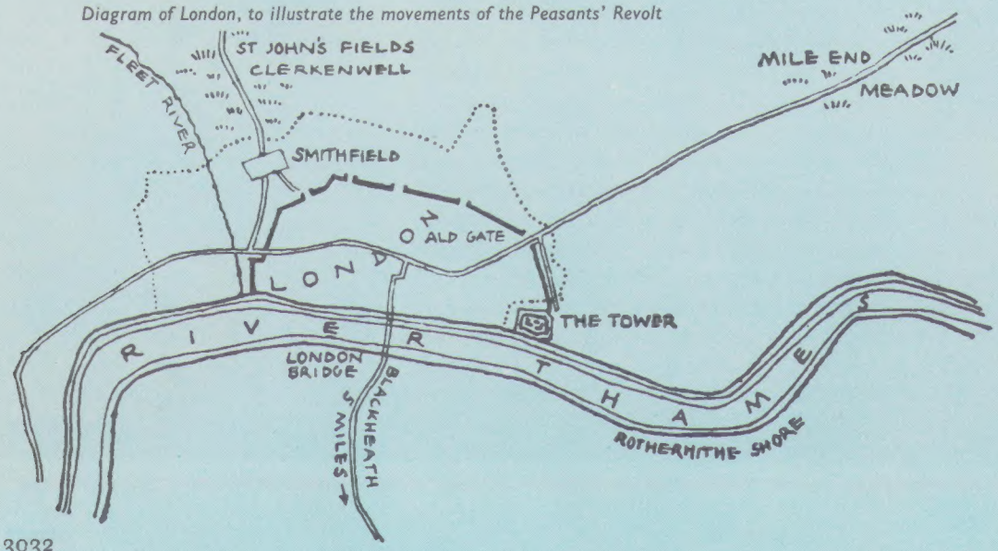
Young King Richard, who covered himself in glory

FOR three days London had been terrorised. The men of Kent and Essex were in arms and, on 12th June, had invaded the capital itself. In their wake they left a trail of ruin. The magnificent Savoy Palace of John of Gaunt had been destroyed; the Lord Chief Justice, the King's Treasurer, and the Archbishop of Canterbury had been murdered. Young King Richard II and his small group of attendants could be forgiven their fears as, on that fateful 15th June 1381, they assembled in Smithfield market-place. They had come in answer to the demand of the rebel leader Wat Tyler for an audience with the King.

It was a dramatic scene – the small royal group clustered only a few hundred yards from the large, menacing rebel army. Wat Tyler left his men and rode over to the King. Addressing the 14-year-old Richard, he made his revolutionary demands – social equality and the confiscation of Church lands. Suddenly one of the courtiers pointed at Tyler and shouted: 'I know that man. He is the biggest robber in all Kent.' Tyler angrily turned on him, drawing his sword. As he did so the courtiers fell on him, and he was slain by Walworth, the Mayor of London. 'They are making him a knight!' cried one of the rebels, seeing the flash of steel. Then the rebels realised what had happened and, seething with fury, prepared to attack. The defenceless royal group were face to face with death, but in this crisis young King Richard galloped towards the threatening mob. The rebels hesitated. They had no quarrel with their boy-king. Then Richard cried: 'I am your leader. Follow me!' They obeyed, and Richard led them to the fields of Clerkenwell where the royal forces were lying in wait. The rebels were trapped.

The courage of King Richard had saved his capital, and, as the rebel leaders were punished and the rest dispersed, the London citizens had reason to thank the young monarch who had ended the three-day reign of terror.

Diagram of London, to illustrate the movements of the Peasants' Revolt



INVASION OF LONDON

How did Wat Tyler's rebels from the Home Counties come so near to toppling the government? Discontent had been growing since the last years of Edward III, when the French wars were going badly and taxation was high. Edward died in 1377, to be succeeded by the 9-year-old Richard II. The men who governed in Richard's name, particularly his uncle John of Gaunt, became increasingly unpopular. In 1379 the peasants were angered by the imposition of a poll tax which fell on all, rich and poor alike. In 1381 another poll tax, at the crushing rate of 1 shilling per head, was imposed. Attempts to collect the tax were resisted. On 2nd June four tax collectors in Essex were murdered, and their heads paraded on pikes. In Kent tax collectors were attacked in Canterbury, and a peasant army converged on Dartford. By 10th June all Kent was in revolt. Maidstone, Gravesend, and Rochester Castle were seized by the rebels and Canterbury Cathedral sacked. The notorious John Ball, a rebellious priest, was released from the Archbishop's prison at Maidstone. The rebels moved on towards London and reached Blackheath on 12th June. There they heard an inflammatory sermon from John Ball. Meanwhile the men of Essex had camped at Mile End outside the city walls.

London was virtually in a state of siege. The King and his attendants had moved into the Tower of London for protection. Across the Thames were Wat Tyler's men, pillaging Southwark and demanding a meeting with the King. In fact the King and a group of courtiers did cross the Thames in a barge in the hope of placating the mob on the Rotherhithe shore, but took fright at the cries of 'Death to the Archbishop and all traitors!' and returned to safety.

It was on 12th June that the rebels entered London. London Bridge was lowered by treachery, and they streamed into the city. By this time the rebels from Kent and Essex were working in close harmony and all acknowledged Tyler as their leader. But despite his efforts to restrain them, his mob ran wild. Looting and pillaging, they destroyed the Savoy Palace and the prisons of Fleet and Newgate. The royal party in the Tower were petrified. Finally it was agreed that the King would have to meet the rebels, and, after all, any promises he was forced to make could always be revoked later. And so, on 14th June, Richard rode out to Mile End and agreed to Tyler's demands – that serfdom be abolished and rents fixed at fourpence an acre. Returning to London, the rebels broke into the Tower and murdered Archbishop Sudbury of Canterbury and Sir Robert Hales, the Treasurer. Then Wat Tyler demanded a further meeting with the King. So it was that on 15th June, Richard met Wat Tyler at Smithfield. He heard Tyler make new demands – the abolition of all bishoprics except Canterbury, which was to go to John Ball, and the erection of a system of social equality. Then came the drama in which Richard covered himself in glory.

PEASANTS' REVOLT

PEASANT DISCONTENT

The poll tax, then, sparked off this amazing revolt. But peasant grievances were much more deeply rooted. English society in the 14th century was largely divided into two groups – the landowners and the serfs. The serfs occupied their land in return for services they rendered to the landowner. Sometimes these services would be in kind, such as wheat or livestock, or in work, such as harvesting. But sometimes these services were 'commuted' into money payments, or 'rents'. This was a process which accelerated throughout the 14th century and eventually led to a break-up of the feudal system as workers became hired for wages and paid their rents in money.

These trends were speeded up still further by the Black Death of 1348, which killed perhaps a third of England's population. The obvious result of this was a shortage of labour, which meant that workers could demand greater payments for their services. But the government attempted to arrest this movement. In 1349 and 1351 it passed rigidly-enforced laws prohibiting workers leaving their land in search of better conditions and limiting the wages they could receive. At the same time some large landowners attempted to re-impose labour services, in kind or work, to avoid paying money at all.

There were other causes of peasant discontent. In particular the Church had fallen into disrepute, and many poor people detested the apparently wealthy clergy. The anti-clerical feeling of the time was reflected in the writings of John Wycliffe (see page 2666). Though he disavowed the rebellion, his works were considered by many to have fostered it. This anti-clericalism is why the Archbishop of Canterbury was singled out for special attack.

The fact is that by the late 14th century some members of the lower classes were beginning to question their status in society. Although the revolt failed, it is, nevertheless, a landmark in the break-up of the old feudal system, and its replacement by the system in which workers became free to move where they liked in search of the best conditions and wages which they were able to obtain.

RICHARD'S LATER YEARS

It is extraordinary that Richard II, whose reign began so heroically, should be remembered as one of the weakest and least successful of English kings. He began his personal rule the year after the Peasants' Revolt and at once began to rely on favourites like Michael de la Pole and Robert de Vere. He treated his favourites lavishly, and the great magnates felt themselves excluded both from the King's confidence and the government of the realm. In 1388 a group of the great magnates, called the Lords Appellant, succeeded in having the King's ministers condemned by Parliament. Pole and de Vere were executed (see page 2387).

In 1389 Richard was able to dismiss the Appellants from office, and for the next eight years he ruled well. But in 1397 he suddenly acted in an absurd, almost unbalanced, manner. He arrested three of the former Appellants – Gloucester, Arundel, and Warwick. Gloucester was murdered, Arundel executed, and Warwick imprisoned.

Richard in his later years, a tragic anti-climax

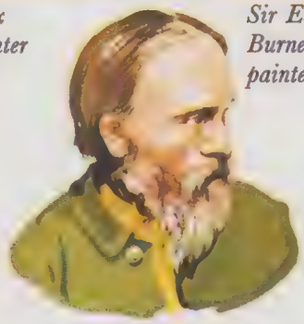
The following year he exiled the remaining Appellants – Henry Bolingbroke and the Duke of Norfolk. He confiscated Henry's inheritance, the Duchy of Lancaster, and when Henry landed in 1399 to claim it, the country flocked to him. Richard was forced to abdicate, reading aloud a statement of his own 'insufficiency and uselessness'. Henry Bolingbroke was crowned as Henry IV, and the Lancastrian dynasty commenced. The following February Richard died, incarcerated in Pontefract Castle – a tragic end to a reign which had begun so brilliantly.

Below left: Walworth, the Mayor of London, draws his sword to slay Wat Tyler. Right: Richard addresses his loyal troops after the rout of the rebels

WILLIAM MORRIS

Dante Gabriel Rossetti, poet and painter

Ford Madox Brown, painter



Sir Edward Burne-Jones, painter

William Morris (1834–1896), *poet, painter, and craftsman*

WILLIAM MORRIS hardly ever changed his mind. He knew what he wanted to do, spent his whole life doing it, and died still saying: 'I want to get mumbo-jumbo out of the world.' By mumbo-jumbo he meant ugliness – in churches and houses, curtains and wallpaper, furniture and books; he also meant machines, mass production, and the dreadful condition of factory workers and miners that made mass production possible in his time.

When William Morris was born, on 24th March 1834, the Industrial Revolution had been under way for more than 80 years. Cramped industrial towns crept over the countryside, and villages were drained of their craftsmen. People had forgotten what it was like to live among beautiful things and do satisfying, creative work.

Morris intended to remind them. He called himself 'a dreamer of dreams', but was much more than that. He wrote enough poetry, stories, sagas, lectures, articles, manifestos, and outraged letters to the Press to fill 24 large volumes. He marched with the workers. He founded and ran what he modestly described as 'a sort of firm for producing decorative articles'. This was actually a flourishing manufacturing company where craftsmen could work by hand in surroundings which were, in the words of their foreman, 'as near paradise as anything well could be'. Moreover, Morris himself created 50 wallpaper patterns, 74 fabric designs, and hundreds of book decorations. He often got up before dawn to write or to weave tapestry. He collected a magnificent library of early printed books and illuminated manuscripts. And five years before he died he started a printing press, whose hand-printed books, exquisitely bound and ornamented, made their own small revolution in the Victorian idea of book design. The cause of his death, according to one doctor, was 'simply being William Morris, and having done more work than most 10 men'.

Yet, despite his prodigious labours, towards the end of his life Morris began to feel that nothing he could do would stop England being corrupted by commercialism, profit-mongering, the enslavement of the working classes, and bad art: 'In 20 years everything will be gone in the countryside. . . . Now that I am grown old and see that nothing can be done, I half wish that I had not been born with a sense of romance and beauty in this accursed age.'

Morris's own choice would certainly have been to have lived in the Middle Ages. Mediaeval knights and ladies, chivalry, blood feuds, colour, and honest craftsmanship had a peculiarly vivid hold over his mind and imagination. Indeed, the Middle Ages already had him in thrall when, as a small boy in Walthamstow, Essex, he rode his pony, dressed in a toy suit of armour and imagining himself a knight. At the age of four he was already deep in Sir Walter Scott's novels of mediaeval love, feud, and adventure.

His father, a rich London businessman who started in life as a city clerk, died in 1847 leaving his wife and nine children very comfortably off. William was the eldest son. Early the next year, when almost 14, he was sent to school at Marlborough College in Wiltshire. The school was new; there were too many boys and no supervision. Morris was taught nothing, but he could wander over the downs, visit the Druid circles at Stonehenge and Avebury, and read up history and church architecture in the school library. He decided to go into the Church and entered Exeter College, Oxford, in 1853 to study for Holy Orders. There he met his life-long friend Edward Burne-Jones. They walked, talked, read aloud, got angry, and travelled together. Morris wrote a new poem on a mediaeval theme almost every day:

'The bird and the anemone' – a characteristic Morris wallpaper showing stylised flowers and birds

A Morris and Co. chair of painted, turned wood with a rush seat

The apples now grow green and sour
Upon the mouldering castle-wall,
Before they ripen there they fall:
There are no banners on the tower.

The draggled swans most eagerly eat
The green weeds trailing in the moat;
Inside the rotting leaky boat
You see a slain man's stiffen'd feet.

It must have been lines like these that made Burne-Jones exclaim: 'He's a big poet.'

Oxford tutors were then almost as indifferent to their pupils as Morris's schoolmasters had been: 'an University education fits a man about as much for being a ship-captain as a Pastor of souls,' he wrote home. When he was 21 he inherited £900 a year and gave up all idea of Holy Orders in favour of a career in some form of art. For nine months he was articled to the Oxford architect G. E. Street. But this was before he was introduced to Dante Gabriel Rossetti, a dark, romantic painter-poet figure of 28, 'a very great man' in Morris's eyes, and the leader of the Pre-Raphaelite Brotherhood (see page 2327). When Rossetti suggested Morris should paint, he moved to London, took a studio with Burne-Jones, and painted.

One of his first pictures was a portrait of a tall, strikingly beautiful woman posing as *La Belle Iseult*. She was Jane Burden, a girl of 18 whom Rossetti and Burne-Jones had found at the theatre in Oxford. Two years later, in 1859, she was married to Morris. Their first house, the Red House, was built for them in 1860 at Upton, Kent, by one of Morris's greatest friends, the architect Philip Webb. It was on the mediaeval pattern, but plain, grand, and streamlined. There was nothing in it that was not useful as well as beautiful. This was remarkable in the age of Victorian clutter.

In 1861, with Rossetti, Burne-Jones, Webb, the Pre-Raphaelite Ford Madox Brown, and other friends, Morris set up in business as 'Morris, Marshall, Faulkner and Co., Fine Art Workmen in Painting, Carving, Furniture, and the Metals'. The firm was housed first in London, then in the country at Merton Abbey, Surrey. Its products included stained-glass windows by Burne-Jones, furniture by Webb, wallpapers and fabrics by Morris, tapestry, carpets, embroidery, and tiles. By serving an apprenticeship, at the age of 41, to a Mr Thomas Wardle of Leek, Morris not only learned dyeing but rediscovered long-forgotten dyes more brilliant and lasting than those then in use. Tapestry was another art he learned from scratch – from a French government handbook published before the Revolution.

La Belle Iseult, *an early Morris portrait*
(Tate Gallery, London)

Morris was 42 when, in 1876, he plunged into politics as treasurer of the Eastern Question Association, the nucleus of an anti-Disraeli campaign to prevent war with Russia. Next year he gave his first lecture, The Decorative Arts. Agitation, protest, and public speaking suited him; he was a burly, impressive figure with a mane of hair and a loud, husky voice. In the same year he founded a crusading Society for the Protection of Ancient Buildings (he called it 'Anti-Scrape'). From 1883, when he openly declared himself a Socialist, to the end of his life he spoke tirelessly on both art and politics at public meetings and street corners up and down the country.

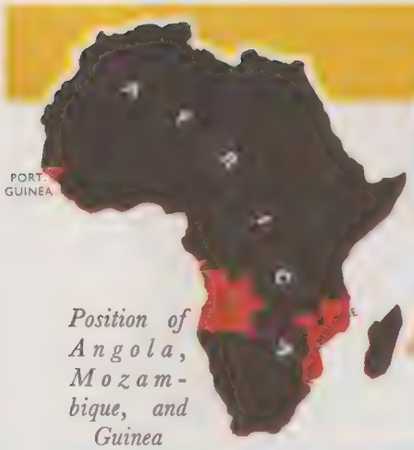
After the shock of seeing Iceland for the first time in 1871, 'that romantic desert' with its 'horrible black mountains', Morris had written some of his best prose. But his new Socialism gave even his poetry a new lease of life. In the last 25 years it had lost its early energy and harsh reality and become an escape, remote, calm, and sad. Now he could write:

O ye rich men hear and tremble! for with
words the sound is rife:
'Once for you and death we laboured;
changed henceforward is the strife.
We are men, and we shall battle for the
world of men and life;
And our host is marching on.'

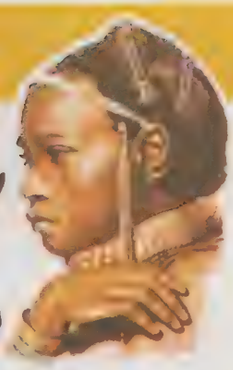
– from one of his *Chants for Socialists*.

Morris's last great work was to found the Kelmscott Press, named after the lovely Gloucestershire manor house that he had taken with Rossetti in 1871. There he died on 3rd October 1896. And there he was carried to his grave on a yellow farm cart with bright red wheels.

ANGOLA, MOZAMBIQUE,



Position of Angola, Mozambique, and Guinea



One of the native women of Angola

WE do not normally think of Portugal as a 'colonial' power, but the territories she controls in Africa cover nearly 800,000 square miles and have a total population of some 12,000,000. During the late 15th and early 16th centuries she became the first European country to establish colonies in Africa, and trading posts were set up on both the east and west coasts. As her power declined many of these were lost, but some survived eventually to grow into Angola, Mozambique, and Portuguese Guinea. They have been relatively little exploited, but since the Second World War considerable development, largely with American aid, has taken place. The problem today is to integrate the white colonists and black native peoples into one society.

ANGOLA

The land. Angola, with an area of over 480,000 square miles, is the largest of Portugal's colonies and about 14 times as big as the mother country. Included within it is a small enclave of territory, Cabinda province, lying north of the mouth of the Congo. But in spite of its great extent large areas are virtually uninhabited, and its average population density is only about 10 per square mile. It consists mainly of a plateau of old, hard rocks some 3,000 feet high, covered with savannah grassland and dotted with trees; in the Nova Lisboa area heights of over 8,000 feet are reached. The headwaters of the Kasai, one of the great tributaries of the Congo, and of the Zambezi rise on the plateau, while rivers like the Cunene and Cuanza flow direct to the Atlantic Ocean. The plateau descends by a series of terraces, often backed by steep bluffs, to a sandy coastal plain, some 150 miles wide in the north but narrower in the south.

Ritual mask used in traditional Angolan ceremonies

The modern buildings of Luanda, the capital of Angola, overlooking the Atlantic

Climate. Angola has a tropical climate of hot summers and mild winters, although temperatures on the coast are reduced by the cold, northward-flowing Benguela current. Because the prevailing winds are offshore the coast has little rain (the annual average fall at Moçâmedes is just 1 inch), and in the south the Cunene is the only river which flows all the year round. Semi-desert scrub occurs over most of this belt, but dense equatorial forest grows in the lower Congo valley. Inland on the plateau there is much more rain, and the land is clothed with savannah grass, which reaches heights of 5 to 12 feet.

Farming. Nearly all the native peoples live by subsistence farming (they grow their own food crops), but the white settlers concentrate on selling crops for cash. The chief native crops are maize (some of which is exported), manioc, groundnuts, and beans. The main cash crops are coffee (the colony's primary export), cotton, sugar cane, cacao (in the hot, wet Cabinda enclave), and oil-palm nuts. Sisal and wheat are also cultivated in the drier southern part of the plateau. Cattle grazed on the central uplands are exported to Katanga to supply her large mining population with meat. In the south-east the Kalahari provides only a poor pastoral economy.

Mining. The last decade has seen economic progress. Rivers and falls have been harnessed to provide irrigation and hydroelectricity. Mining has been increased, especially of diamonds (of which Angola is one of the world's chief suppliers), iron ore, copper, manganese, platinum, and petroleum. Industrial products include cigars, cement, cotton textiles, and various processed foodstuffs.

Towns. Luanda, the capital and largest city of Angola, grew up as the oldest Portuguese trading post south of the Congo; it is the colony's administrative centre. Today Lobito, blessed with an excellent harbour, has overtaken Luanda as the main port; it serves Angola and Katanga. An attempt made to create a new centrally placed capital city, Nova Lisboa, failed because of the new town's isolation. Other important towns are Benguela and Moçâmedes.

AND PORTUGUESE GUINEA

MOZAMBIQUE

Land and climate. Almost half of Mozambique consists of a broad coastal plain. In the north it is narrower and merges into grass-covered uplands with an average height of over 3,000 feet. The plain is widest where two of Africa's great rivers – the Zambezi and the Limpopo – thread their way through mangrove swamps and sand bars to the sea. The climate is one of hot, wet summers and mild winters, the latter being in part due to the warming effect of the southward-flowing Mozambique current. But inland from the wet coastal regions the rainfall decreases markedly, and much of the interior plateau is very dry. The arid heat of the Tete district has earned it the title of 'the hell of the Zambezi'.

Farming. The north of the country is the chief farming region, cotton and groundnuts both being grown here for export. Other crops include cashew nuts, rice, tea, potatoes, and cassava. In the centre and south maize is more important, while sugar cane, citrus fruit, and bananas are cultivated on rich alluvial deposits alongside the river estuaries. But losses often result from lack of drainage and flood control. Cattle are grazed on the grasslands of the interior.

A view of Lourenço Marques, the up-to-date capital of Mozambique

FACTS AND FIGURES

	Angola	Mozambique	Guinea
Area (sq m)	48[illegible]25	297,731	3,948
[illegible]	4[illegible]	[illegible],732,[illegible]	[illegible]480
[illegible]	[illegible]	9	[illegible]
Capital	[illegible]	[illegible]	[illegible]
	[illegible]	Maputo	[illegible]
	[illegible]48	[illegible]	[illegible]
Industries	[illegible]	Machinery, petroleum, textiles	[illegible]
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
Exports	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]

Minerals and industry. Mozambique is predominantly a farming country, but she does have some valuable mineral deposits, including gold, copper, mica, bauxite, iron, and coal; the last-named is used mainly to supply the Beira railway. There is little industry, though a number of new factories have been opened up since the war – for example, a cotton mill, a jute mill, a cement works, and several manufacturing plants. A massive hydroelectric station on the Revué river (west of Beira) is an important supplier of power for industry and homes; its surplus is exported to Southern Rhodesia.

Communications. Improvements are taking place. New constructions include a seaport at Nacala and an international airport at Lourenço Marques. Railways and roads have been improved, though many of the latter are deep in mud during the wet summer. The maintenance of the transport net is essential to the colony's economy, for she leans heavily on the income from the transit trade of the countries of the interior. Thus Beira is the gateway to the Rhodesias and Malawi, and Lourenço Marques is one of the chief ports for the Johannesburg gold-mining and industrial area of South Africa. The railways connecting these districts with the coast are therefore of vital significance.

PORTUGUESE GUINEA

Portuguese Guinea is very largely a land of estuaries and islands. It consists of a monotonously flat coastal plain and an interior of low plateaux, which rise to about 700 feet in the foothills of the Futa Jallon highlands. Mangrove swamps (which grow only in tidal areas) fringe the coast and the deeply penetrating estuaries. They are succeeded by fresh-water swamps, forest, and savannah grasslands. These variations in vegetation reflect the increasing dryness of the climate away from the coast, which receives heavy monsoon rains in summer. Almost the whole population lives by farming, much of it being primitive shifting cultivation. The chief food crop is rice, grown in flooded fields reclaimed from mangrove swamps. Oil-palm nuts are also grown in the lowlands; the oil is used locally, and the kernels are exported. Groundnuts from the plateau form the main export crop, most of the oilseeds being sent to Portugal. Industry is almost entirely absent. Bissau is the capital and chief port.

THE RADIO

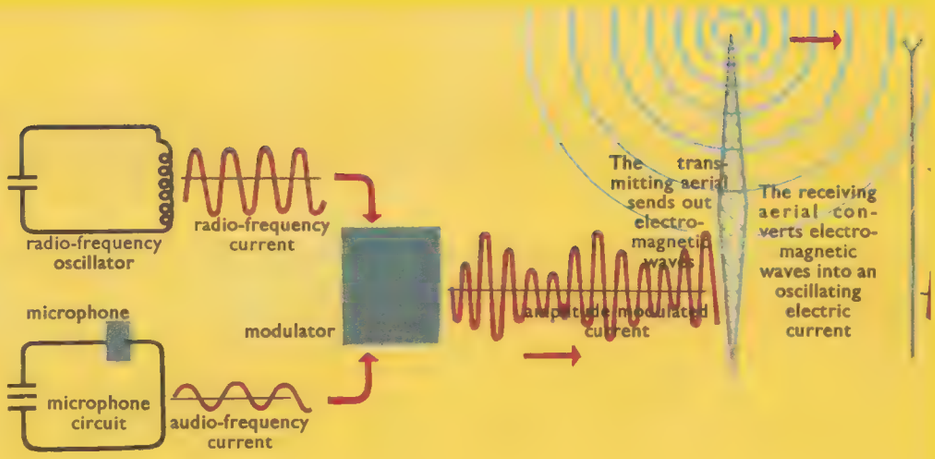
'THIS is the BBC Home Service, here is the news. . . .' These words are heard every day by millions of people, and all of them receive this news at almost the same instant that the newsreader is speaking in the BBC studio. The range of radio is almost unlimited; it can be used as 'walkie talkie' to direct search-parties to an injured climber; it can describe prize-fights from America; and it can be used to control space probes in the depths of the Solar system.

Before radio communication was invented the quickest way of passing messages, news, and information from one person to another was by using sound waves – in other words, by speaking. However, sound will only travel short distances – you know this because you can only shout messages over a few hundred yards. To make communication more efficient the sound wave must be converted into another type of wave which travels farther and, moreover, faster (sound travels at about 750 mph). With the coming of the radio it was possible to send speech and music over thousands of miles at a speed of 186,000 miles a second. The secret of radio is that it uses electromagnetic waves.

Most of us are familiar with the idea that sound waves are variations in the pressure of the air; as the sound wave passes, the air is first compressed and then rarefied. For sound to travel from one point to another it must pass through matter – solid, liquid, or gas – because it is the change in pressure in the matter which makes the sound. Electromagnetic waves can be thought of as changes in magnetic and electric 'pressure'. The 'pressures' first increase then decrease as the wave passes in a similar way to sound. Unlike sound waves, electromagnetic waves can travel through empty space at 186,000 miles a second. Electromagnetic waves can also pass through solid objects far more easily than sound waves.

If we are to send speech and music in this way a means must be found of converting sound waves into electromagnetic waves and then reconverting these back into sound waves so that they can be heard.

The sound waves which the human ear is capable of



A simplified diagram of a radio transmitter. The amplifying stages have been left out

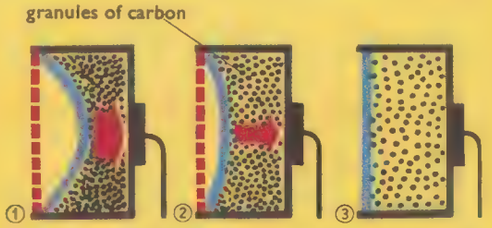
appreciating vary from frequencies of about 30 cycles per second (cps) up to about 18,000 cps. A frequency of 30 cps means that 30 complete sound waves will reach the listener in one second; this is a low, humming note. A sound wave with a frequency of 18,000 cps is very high – in fact it is inaudible to most older people.

It might seem that the easiest way to convert sound to electromagnetic waves would be to do so directly – that is, to make the electromagnetic waves have exactly the same frequency as the sound waves. However, it is very difficult to produce a powerful source of electromagnetic waves at the relatively low frequency of sound waves, and they would be very hard to detect; also if several radio stations broadcast using the same method it would be impossible to separate the programme of one station from the others; a chaotic jumble would result.

The frequencies of electromagnetic waves most suitable for long-distance communication (*radio waves*) lie between 100,000 cps or 100 kc/s (1 kc/s = 1,000 c/s = 1 kilocycle/second) and 100,000 kc/s. Even the lowest of these frequencies is much higher than the highest frequency sound wave which can be heard. Clearly a sound wave cannot be converted directly into a radio wave. How can we overcome this problem? If we cannot give the radio waves the same frequency as the sound waves, is there any other way of giving the radio waves the 'shape' or characteristics of the sound waves? There are ways, and one of them means altering the *amplitude* (see diagram above) of the radio wave. This is adjusted according to the frequency of the sound wave. Thus the radio wave is transmitted on only one frequency, but it also contains these varying amplitudes which register the characteristics of the sound waves. The process is known as *amplitude modulation*, and the sound wave (or audio-frequency wave) is said to modulate, or change, the amplitude of the radio wave. The sound wave is thus called the *modulating wave*, while the radio wave is called the *carrier wave* since it carries information about the sound wave.

MODULATION AND TRANSMISSION

Before the sound waves can be used to modulate the radio waves they must be converted into changes in electric current by a *microphone*. The simplest of these

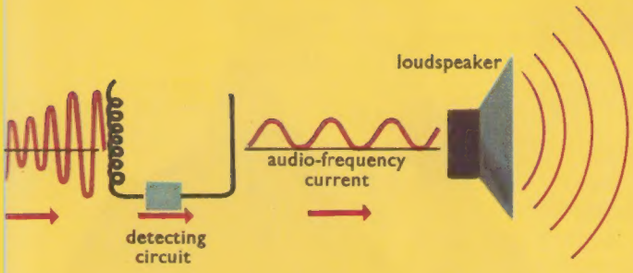


is the carbon microphone. This consists of a small box loosely packed with tiny granules of carbon; on the front of the box is a thin, flexible metal diaphragm. An electric current is made to flow from the metal diaphragm, through the carbon granules, to a metal plate at the back. When a sound wave hits the diaphragm it is pressed inwards ① and the carbon granules are squashed together; their electrical resistance to the current decreases and the current itself increases.

THE RADIO-FREQUENCY SPECTRUM

One carrier wave is distinguished from another by its frequency or its wavelength. The frequency and wavelength are related by a simple formula, the velocity of the wave equalling the frequency multiplied by the wavelength. The velocity of all radio waves is constant and equal to that of light; if we double the frequency of a wave, its wavelength must be halved.

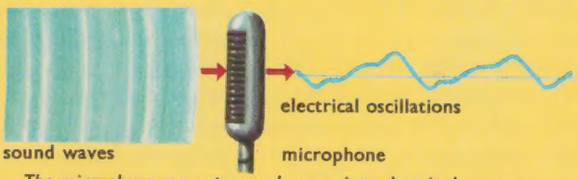
The wavelength of radio waves varies from several miles to about 1 foot. Waves with a wavelength of several miles to a few hundred yards are known as long waves; the BBC Light Programme is transmitted with a wavelength of about 1 mile (1500 metres). Wavelengths between 500 yards and 100 yards correspond to medium waves, which are used for most broadcasting in European countries. From 100 yards down to about 10 yards are the short waves. These are used for sending radio programmes between continents and even round the world. This is possible because, unlike the others, these short waves are reflected from a layer in the atmosphere called the ionosphere, between 150 and 250 miles high. The waves may undergo a whole succession of reflections from the ionosphere to the earth and travel many thousands of miles. The waves used for VHF radio and for television are still shorter; a typical television wavelength may be only 2 or 3 yards, or even as short as 1 foot.



A simplified diagram of a radio receiver

As the pressure of the sound wave decreases the diaphragm returns to its rest position ② and ③ and the carbon granules spread out again; their electrical resistance increases and the current decreases. The variations in air pressure which made up the sound wave have become converted into variations of electric current.

The carrier wave is generated by an electrical circuit in which the current is made to oscillate to and fro with a frequency of several hundred kc/s.



The microphone converts sound waves into electrical energy

Each radio station is allotted one carrier-wave frequency which must always be kept constant.

The radio-frequency current from the oscillating circuit and the audio-frequency current from the microphone pass into a *modulator*. This is a complex electrical circuit which makes the amplitude of the radio-frequency current change with the frequency and amplitude of the current from the microphone. The modulated current is amplified many times and passed to a *transmitting aerial*. The oscillating current causes the electrons in the aerial wire to surge up and down. As they do so they emit electromagnetic waves which travel outwards from the aerial at the speed of light. The changes in electric and magnetic 'pressure' in these waves correspond to the changes in the oscillating current which left the modulator. The waves leave the transmitting aerial and spread out in all directions, becoming weaker the farther they travel.

THE RADIO RECEIVER

A receiver is essentially a transmitter in reverse. The first part is the aerial, which converts radio waves into electric currents. When the radio waves hit the aerial wire they cause the electrons in it to surge up and down at the same frequency. The receiver must respond to only one radio station, out of many hundreds that may be transmitting radio waves, and so the aerial circuit must be 'tuned' to the *carrier-wave frequency* being transmitted by the station. This ensures that the electrons in the aerial can oscillate very freely at the selected carrier-wave frequency but hardly at all at any other. When a radio set is changed from one station to another all that happens is that the frequency is changed at which the electric current can oscillate in the aerial circuit.

The strength of the aerial current is weak particularly if the receiver is far from the transmitter, so it is necessary to increase its size or amplify it. The amplified oscillations then pass into the detecting circuit.

THE DETECTOR

The detector has the job of splitting up the audio-frequency part from the radio-frequency part. It may be a triode valve, a diode valve, or a crystal of germanium or silicon, but in all cases it works in the same way. The detector has the property of allowing electric current to flow through it in one direction but not in the other. When used in a circuit it can be made to allow the positive part of a wave to pass but not the negative part. When the modulated carrier-wave current reaches the detector it is let through when it surges one way but not when it surges the other. There is now a series of electrical impulses all in the same direction, their size changing with the frequency of the original sound wave. The impulses are now amplified and passed to a loudspeaker. Each impulse is too short to affect the loudspeaker individually; it only responds to the much slower change of amplitude of the impulses which has the frequency of the original sound wave. The loudspeaker converts these audio-frequency electrical oscillating currents back into sound.

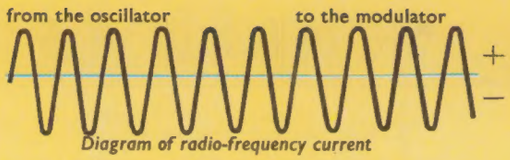


Diagram of radio-frequency current

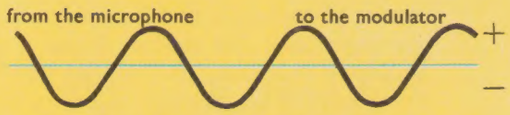
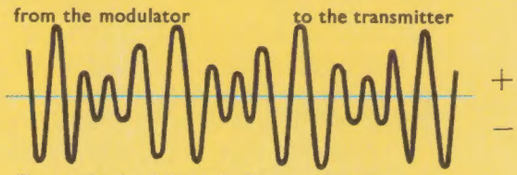
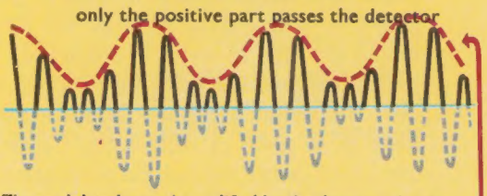


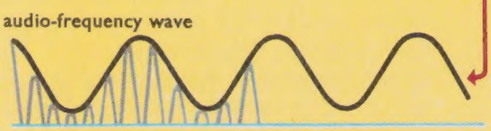
Diagram of audio-frequency current



The amplitude of the radio-frequency carrier wave is modulated by the audio-frequency wave



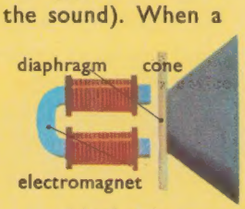
The modulated wave is modified by the detector circuit



Current from the detector is amplified and passed into a loudspeaker which only responds to the audio-frequency current

THE LOUDSPEAKER

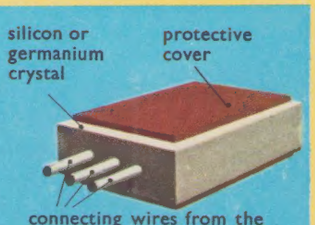
The electrical impulses are fed into an electromagnet. Near this is supported a thin, flexible metal diaphragm attached to a cone (which amplifies the sound). When a large electrical impulse of audio-frequency reaches the electromagnet the strength of its magnetic field increases and it pulls strongly on the diaphragm; a small impulse creates only a weak pull on the diaphragm. The diaphragm and cone are caused to vibrate and emit sound. The loudspeaker reproduces almost the exact sound that was detected by the microphone at the radio station.



A loudspeaker

TRANSISTORS

Advances in physics have made it possible to replace valves by transistors. These are small slices of specially prepared germanium or silicon which can be used to control electric currents in the same way as valves. They have many advantages over valves; they are much smaller, cheaper, unbreakable, do not give out much heat, work immediately they are switched on, and last longer.



A transistor

SAMUEL TAYLOR COLERIDGE

THE popular conception of a poet as a romantic, unpractical dreamer fits Coleridge well. As a child he was an avid reader of romances and fairy-tales, finding in books like *Robinson Crusoe* and *The Arabian Nights* a means of escape from his unhappy childhood. He did not have the same interests as the other boys of his own age, and as a result they did not like him (he admits that he was a 'tell-tale'). Through turning his mind to books, as he wrote later: 'I became a dreamer and acquired an indisposition to all bodily activity.'

Coleridge always remained a dreamer. One of his great poems, *Kubla Khan*, actually came into his mind while he was asleep. He had retired to a lonely farmhouse on Exmoor in the summer of 1797. Being slightly unwell he took a drug which caused him to fall asleep just as he was reading some words about the Khan Kubla in an old book. In his sleep he 'composed' a complete poem about the Khan and when he awoke he began at once to write it down; but he was interrupted by 'a person on business from Porlock', and when he returned to his desk the vision had gone from his mind. So *Kubla Khan*, as we have it, is only 54 lines long. Coleridge claimed that he had 'dreamed' some two or three hundred lines.

Samuel Taylor Coleridge was born in 1772 at Ottery St Mary in Devon. In 1781 the boy was sent to Christ's Hospital school, where he wrote his earliest poems; and at the age of 19 he went up to Jesus College, Cambridge. He took to this new world with enthusiasm. He and his friends would talk far into the night about politics, the French Revolution, and the ideals of Liberty and Equality. It was an exhausting life. Soon Coleridge was reduced to despair, and almost to suicide, by his debts and by an unhappy love affair. In 1793, in order to escape, he joined the army under a false name; but after a year his brothers helped him to get out of it.

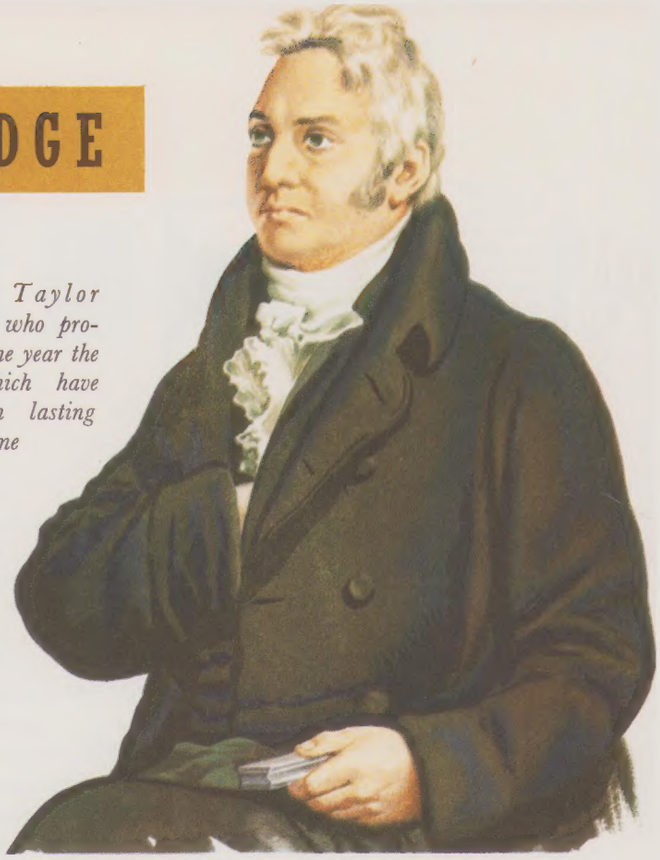
Coleridge and the Wordsworths

The next few years were the most important of Coleridge's life. First, with the poet Southey, he was inspired by the idea of establishing a utopian (ideal) community in America where a few close friends might live in perfect freedom. The idea fell through, but it brought about Coleridge's marriage to Sara Fricker, a friend of Southey. After a few years this marriage was not a success. Then, in 1797, Coleridge took the farmhouse at Stowey in Somerset, and, soon after, William Wordsworth and his sister settled nearby (see page 2352). Friendship with the Wordsworths was the decisive influence on Coleridge's poetry, and nearly all his best work, including *Kubla Khan*, *The Rime of the Ancient Mariner*, and the first part of *Christabel*, was written in the following months. His work showed a brilliant imagination and a great range of emotion, his mood in *The Ancient Mariner* alternating between desolation and horror, as in:

Alone, alone, all, all alone
Alone on a wide wide sea!
And never a saint took pity on
My soul in agony

and quiet contemplation:

Oh Sleep! it is a gentle thing,
Beloved from pole to pole,
To Mary Queen the praise be given!
She sent the gentle sleep from Heaven,
That slid into my soul.



Samuel Taylor Coleridge, who produced in one year the poems which have given him lasting fame

The two poets planned a joint volume in which Wordsworth would reveal the poetry to be found in ordinary things, and Coleridge would write about the supernatural and the romantic. This volume, *Lyrical Ballads*, appeared in 1798; *The Ancient Mariner* was Coleridge's main contribution. With its revolt against artificiality and 'poetic language' it heralded a revolution in English poetry.

Inspiration slackens

In 1798 Coleridge and the Wordsworths visited Germany, where Coleridge became greatly interested in German philosophy. On return to England he could not recapture the inspiration of the previous year. Marriage now became more and more of a burden, since he had fallen in love with another woman. To escape from this situation and from increasing pain caused by ill-health, he took to the drug opium and became an addict.

The years from 1810 to 1816 were the worst in Coleridge's life. He had quarrelled with Wordsworth, and lived in poverty and misery, often sick and drugged, giving lectures and writing his great prose work, the *Biographia Literaria* (a mixture of autobiography, philosophy, and literary criticism). In 1816 he moved into the Highgate home of Dr James Gillman, where he stayed for the rest of his life. Under the doctor's care his health improved, and he was able to publish some of his earlier work, including *Christabel*, *Kubla Khan*, and the *Biographia Literaria*. He died in 1834.

Coleridge is remembered for a handful of poems of supreme imaginative power (*The Ancient Mariner*, *Kubla Khan*, *Christabel*, *Dejection*, *Frost at Midnight*, and a few others), and for his literary criticism, especially of Wordsworth and Shakespeare. His friends admired him also for his brilliant conversation, his philosophy, and his preaching. He called Shakespeare 'myriad-minded', and the adjective could well be applied to himself, for no other English poet has had such breadth of interests as Coleridge. His tragedy was that these many interests, and the practical difficulties of his life, stifled the poet in him. Perhaps he worked himself out as a poet in that extraordinary year in Somerset.

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summer's Day. And so the Egyptian calendar became a day *ahead* of the true situation. After eight years it was two days ahead, and so it went on until in one year Midsummer's Day by the Sun fell on Midwinter's Day by the calendar. Then, after an equal period, all came right again – for one year. The time taken for a complete cycle is 1476 years and is known as a *Sothic cycle*.

Making a calendar to fit the year

As late as the 4th century B C the Roman calendar was based on the monthly changes of the Moon. Not only was it in great disorder owing to the carelessness – or probably the incompetence – of the High Priest, but it was also very difficult to use. When Julius Caesar went to Egypt he realised that the Egyptian calendar, in spite of its shortcomings, was superior to the Roman one, and he decided to introduce it throughout the Empire. To help him in his work he had the Egyptian astronomer, Sosigenes, and in 46 B C they designed a calendar, the *Julian calendar*, which was even better than the original Egyptian one.

Caesar's calendar had 365 days in each common year, but in each fourth year, which we now call a *leap year*, there were 366 days due to the addition of an *intercalary day*. This day, being extra, had the effect of *holding the calendar back* while the Earth completed one revolution. The calendar was thus brought into step with the position of the Earth and thus with the seasons.

The Pope steps in

Unfortunately, though they had tried hard, Caesar and Sosigenes had still not been completely successful in their reorganisation of the Roman calendar; the exact length of the solar year is 365 days 5 hours 48 minutes 46·43 seconds, and so they had overcorrected by about 11½ minutes a year. Consequently, by Renaissance times the calendar was 10 days *behind* the Sun, and Pope Gregory XIII, fearing that the discrepancy would eventually disorganise arrangements for religious festivals, decided that something had to be done.

The Pope's method for making the calendar catch up was quite a simple one. He merely decreed that it should jump 10 days, and thus the day which would normally have been 5th October 1582 became 15th October 1582 instead. In addition, and to prevent a recurrence of this situation, he decreed that when the number of a year ended in two noughts – for example in 1700 and 1900 – the year would not be a leap year as in the Julian calendar unless the number was divisible by 400 without remainder, as in the years 1600 and 2000.

The English, being entirely insular and largely Protestant, took a rather negative view of Papal interference with what they liked to think of as a perfectly satisfactory calendar, and they refused to co-operate; or at least for 170 years they refused to co-operate. By that time the Julian calendar was 11 days ahead of the solstices, and when it was finally put right in 1752 by the simple process of missing out 11 days there were riots in London by a populace who thought that they were being cheated of 11 days of their lives. The cry, 'Give us back our 11 days', is now part of English history.

The sidereal year

An alternative way of defining the length of a year is to measure the time which the Earth takes to make the journey from one point on her orbit back to the same point. This measurement, though it sounds difficult, is easily made by astronomers when they use the stars to calculate the Earth's exact position. When the year is measured in this way it is found to be 365 days 6 hours 9 minutes 9·5 seconds long, or roughly 20 minutes longer than the year measured by the solstice-to-solstice method.

Because this longer year is obtained by using the stars as a reference system instead of the Sun it is called a *sidereal year* (from the Latin *sidus*, a star). It is an exact measure of the time taken by the Earth to complete one orbit around the Sun, and it is quite independent of the tilt of the Earth's axis. The difference between its length and that of the solar year is due to several irregularities in the Earth's movement, in particular that due to the steady change in the direction of tilt of the axis. This top-like wobble, or *precession* as it is called, moves the tilt of the axis by 50 seconds of arc each year, an alteration which makes the solar year on which the calendar is based just 20 minutes shorter than a sidereal year.

THE SIDEREAL YEAR

The sidereal year is the time taken by the Earth to complete one journey around the Sun. During this time the planet makes 365¼ revolutions relative to the Sun, but since it also moves around the Sun once it makes 366¼ revolutions relative to the stars. Each sidereal year therefore contains 366¼ sidereal days, each of which is roughly 4 minutes shorter than a solar or tropical day.

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CALENDARS OF THE WORLD

The use of the calendar which Pope Gregory introduced, which is called the *Gregorian calendar*, spread slowly to all the Christian countries of the world. The peoples of the non-Christian countries, however, mostly preferred to retain their own calendars, and it was not until this century that the Gregorian calendar became almost universal. Some countries have adopted the Gregorian system with modifications to suit their own traditions, particularly in respect of the time from which the counting of the years begins. Others have adopted the calendar for everyday and commercial purposes, but maintain their traditional calendars in parallel for religious or political reasons.

The **Hebrew** calendar counts the years from the time at which tradition teaches that man was created. This date corresponds to 3760 B C in the Gregorian calendar.

The **Muslims** have a calendar which starts at A D 622, the year of the flight of Mahomet from Mecca to Medina. Since the Muslim year has only 354 days, the calendar gets out of step with both the seasons and the Gregorian calendar.

The **Japanese** use the Gregorian calendar to subdivide the years, but they count the years from the beginning of each new emperor's reign.

The **Buddhists** of Burma count their years from the death of Buddha, 543 B C.

The **Chinese** use a Gregorian calendar similar to that used in the Western world.

The Christian **Copts** of Egypt and the Sudan count their years from the Diocletian persecution in A D 284.

Many calendars are used in **India,** the most important being the national calendar of the Republic, which counts from A D 78, and the Gregorian calendar, which runs concurrently.

The **Persians** count from the flight of Mahomet in the same way as the Muslims of the Arab world. However, the Persian system differs by the adoption of a year of 365¼ days.